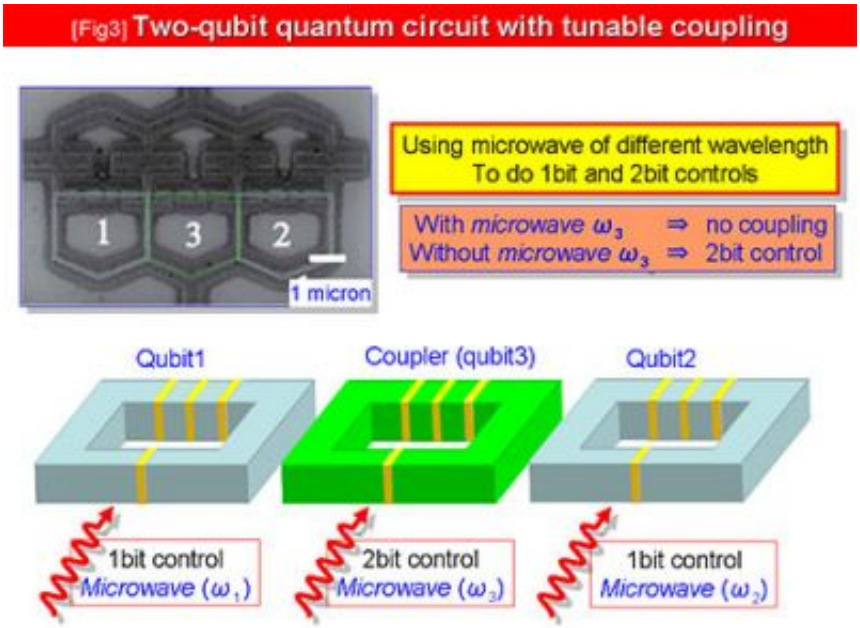
NEC, JST and RIKEN demonstrate world's first controllably coupled qubits

May 3 2007



Two-qubit quantum circuit with tunable coupling

NEC Corp., Japan Science and Technology Agency (JST) and the Institute of Physical and Chemical Research (RIKEN) have together successfully demonstrated the world's first quantum bit (qubit) circuit that can control the strength of coupling between qubits. Technology achieving control of the coupling strength between qubits is vital to the realization of a practical quantum computer, and has been long awaited in the scientific field.

The quantum computer, when it is finally brought to fruition, is expected to far surpass the capabilities of even the most modern of today's supercomputers. Actual computing in a quantum computer is carried out by manipulating the quantum state of qubits in time sequence by external controls. To achieve such manipulation, it is necessary to control the: 1. States of individual qubits, 2. States of two qubits (logic operation), and 3. Ability to turn on /off the coupling between qubits.

NEC, JST, and RIKEN have already announced successful development of key technologies for the world's first solid-state qubit and the world's first two-qubit logic gate, based on solid-state technology that excels in its ability to integrate qubits. Following these achievements, the research group addressed the controllable coupling of qubits as the next logical step in realization of a practical quantum computer. Their new research result represents the world's first successful demonstration of controllably coupled qubits.

To date, the coupling of qubits has been difficult to control. In order to realize this control, the research group devised an original mechanism that employs another qubit in between the two qubits for coupling. The coupling qubit functions as a non-linear transformer that is able to turn on and off the magnetic coupling between the two qubits, and on/off control is achieved simply by inputting a microwave. Moreover, coupling operation has been achieved without shortening the lifetime of each qubit. Scalability is also realized through the repetition of coupled two-qubit units - a feature necessary for future quantum computers.

To demonstrate the operation feasibility of the controllable coupling scheme, the research group employed a coupled two-qubit system, the smallest quantum logic unit, to carry out a multi-quantum control experiment involving the turning on and off of the coupling. As a result, a simple quantum protocol has been successfully demonstrated, allowing controllable coupling for the execution of quantum algorithms.

In the near future, NEC, JST, and RIKEN, plan to implement a larger-scale, more elaborate quantum computation, aiming for the realization of a practical quantum computer.

The result of this joint research will be published in the May 4th issue of the international weekly science journal, *Science*.

Source: NEC Corporation of America